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## IN THE U.S. PATENT AND TRADEMARK OFFICE

Docket No. 04109/0100

Transmitted herewith for filing is the patent application of

Inventor: Tripplett, et al.

For: Method and Apparatus for Production of Tubing

Enclosed are:

☒ Declaration and Power of Attorney☒ Specification☒ 11 (3 each) informal sheets of drawing☐ An assignment of the invention☐ A certified copy of a \_\_\_\_\_ application☒ A verified statement to establish small entity status under 37 C.F.R. §1.9 and 37 C.F.R. §1.27.☒ Information Disclosure Statement

The filing fee has been calculated as shown below:

Entity	Small Entity		Other than Small	
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BASIC FEE				345
TOTAL CLAIMS	38-20=	18	x 9=	162
INDEP. CLAIMS	5-3=	2	x 39=	78
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PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

TRIPPLETT, ET AL.

Serial No.

Filed: CONCURRENTLY

For: METHOD AND APPARATUS  
FOR PRODUCTION OF TUBING

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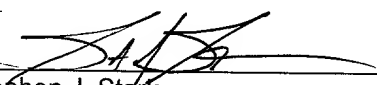
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Sir:

Transmitted herewith is the Specification; Cover Sheet; Declaration and Power of Attorney; Verified Statement Claiming Small Entity Status; check in the amount of \$585.00 to cover the filing fee; three (3) sets of informal drawings for the above-referenced patent application; Information Disclosure Statement and Form PTO-1449. These documents are being transmitted pursuant to the provisions of 37 C.F.R. 1.10 via Express Mail.

Respectfully submitted,

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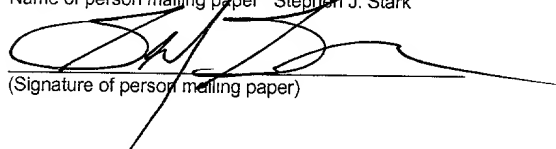
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P. 2

Applicant or Patentee: Triplett, et al.

Attorney's

Serial or Patent No.:

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Filed or Issued: Concurrently

Title: METHOD AND APPARATUS FOR PRODUCTION OF TUBING

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS  
(37 CFR 1.9(f) & 1.27(c))--SMALL BUSINESS CONCERN

I hereby declare that I am

☐ the owner of the small business concern identified below:☒ an official of the small business concern empowered to act on behalf of the concern identified below:NAME OF SMALL BUSINESS CONCERN Quality Machine Company, LLCADDRESS OF SMALL BUSINESS CONCERN 3601 Old Tasso Rd., Cleveland, TN 37312

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.12, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees to the United States Patent and Trademark Office, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled METHOD AND APPARATUS FOR PRODUCTION OF TUBING by inventor(s) David Triplett, Gary Winner, Tom McKeehan, and Claude Ellis described in

☒ the specification filed herewith☐ application serial no. \_\_\_\_\_, filed☐ patent no. \_\_\_\_\_, issued

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights in the invention is listed below and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e). \*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

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I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

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NAME OF PERSON SIGNING David TriplettTITLE OF PERSON IF OTHER THAN OWNER GovernorADDRESS OF PERSON SIGNING 3601 Old Tasso Rd., Cleveland, TN 37312SIGNATURE David Triplett

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9/7/00

APPLICATION FOR LETTERS PATENT  
THE UNITED STATES OF AMERICA

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**METHOD AND APPARATUS FOR PRODUCTION  
OF TUBING**

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## METHOD AND APPARATUS FOR PRODUCTION OF TUBING

### BACKGROUND OF THE INVENTION

The present invention relates generally to production of thermoplastic tubing and formable plastic products and, more particularly, relates to a method and apparatus for producing small and large diameter thermoplastic tubing and composite tubing structures.

### DESCRIPTION OF RELATED ART

One known method for manufacturing corrugated pipes is to extrude a tube of thermoplastic from a head and then conform that tube to the interior of a corrugated mold tunnel formed by mold blocks. Mold blocks typically come in pairs and mate together to form a portion of the mold tunnel, and the thermoplastic is either blown into shape (by pressure created within the plastic tunnel) or vacuumed into shape (where vacuum draws the air from around the mold tunnel). Typically, the mold blocks operate in a clam shell-type fashion such that each of the mold block pairs pivot on an axis into mating engagement with one another. Examples of clam shell type corrugators are shown in U.S. Pat. Nos. 5,645,871; 5,494,430; 4,439,130 and others. The clam shell-type shape of mold blocks are susceptible to "sawtooth" imperfections which can occur throughout the mold tunnel. Sawtoothing occurs when successive mold blocks are tilted slightly rather than perfectly aligned with the axis of the mold tunnel. The hinged mold carrier, when closed, has a tendency to lean back in the opposite direction of travel during the molding process. This "sawtoothing" creates molding lines as well as a potential loss of vacuum.

The clam shell type mold carriers typically require the use of multiple custom-machined components and have a high manufacturing cost. The hinge pin is subject to external forces which results in wear on the hinge pin. A worn hinge pin may not allow the mold to pivot closed properly which could prevent the tubing from forming properly. Furthermore, wear and misalignment of the pivoting pairs may result in the hinged mold carrier bending or breaking some of the custom-machined components.

At least one prior art device, U.S. Pat. No. 5,510,071 teaches a pair of mold blocks that are operated differently from the clam shell variety. Instead of using a hinged pivot, as is customary in the art, this device allows for transverse linear reciprocal travel for closing and opening of the mold block pair. The apparatus taught by the '071 Patent utilizes reciprocal linear travel for the carriage supporting the mold blocks. There is no teaching in the '071 Patent to utilize linearly opening and closing of mold block pairs in a continuous loop corrugator.

Typically mold blocks must be maintained within an acceptable range of temperatures during the molding process. However, during the extrusion process, hot plastic is extruded into the mold blocks which tends to heat the blocks. To maintain acceptable temperatures the blocks must be cooled. Cooling of mold blocks may be a problem. Inadequate cooling of mold blocks may lead to excessive temperatures for the molding process and result in degradation of the quality of molded tubes. Too much cooling may result in crackling of the exterior surface of molded tubes thereby giving the impression of an alligator-like skin on the pipe surface. Traditionally, mold blocks have been water cooled with internal cooling passages within each block. Failure of water lines and water leakage is a problem for many corrugator designs. If significant water leaks into the mold cavity during molding, a defective product may result, requiring the

corrugator to be shut down, the leak located and the mold block or other leaking component repaired.

Accordingly improved cooling techniques are desired.

In order to keep mold blocks in contact with the product to produce good forming characteristics, prior art corrugators utilize chain driven mold blocks where mold blocks are located substantially around the entire perimeter of a continuous path. At least one improvement is illustrated by U.S. Pat. No. 5,494,430 and 5,531,583 where a mold train drive and a shuttle drive are utilized to minimize the number of mold blocks. Nevertheless, this system relies on gearing and at least two separate chain drives: one to shuttle molds from the end of the mold tunnel to the beginning of the mold tunnel and one to drive molds through the mold tunnel.

The mechanical drive system utilized by corrugator designs in the prior art typically have mechanical drives comprised of motors, gear boxes, gear reductions, transmissions, sprockets, chains, idler sprockets, power take off shafts and other mechanical drive systems. These drive methods and systems may require extensive maintenance. Furthermore, these drive methods are subject to wear as many components are in direct contact with one another. There is also the potential problem of backlash in the driving mechanisms, which may be accentuated in the propulsion of the molds.

The corrugators such as taught by U.S. Pat. Nos. 5,494,430; 5,645,871; and others are known as vertical style corrugators. A forming mold tunnel is in line with the extrusion head die. The non-forming (return) of the mold chain is typically overhead or below the product center line. As shown in Figure 2 of U.S. Pat. No. 5,494,430, the molds which are not in use in the mold process are typically open and cannot be used in the manufacture of product until they return to the forming side of the corrugator. This results in a machine having a greater height in the vertical plane and does not utilize

the non-forming molds in production. U.S. Pat. No. 5,257,924 teaches at least one method for using multiple molding sections in a corrugator.

Maintaining a vacuum is another concern in many corrugator and mold designs. U.S. Pat. Nos. 4,718,844 and 5,059,109 teach at least two different vacuum configurations for mold blocks.

5 Thermoexpansion of forming molds can cause vacuum loss through the vacuum interface during production. The vacuum interface is typically a rigidly fixed device that interfaces with the molds. If the interface is not complete, vacuum leakage will occur. Although it appears that improvements have been made to the mold blocks for maintaining vacuum, the interface with the vacuum does not appear to have been thoroughly perfected.

10 With the clam shell style mold carriers, the mold carriers typically operate on an oval track. The radius on the curved portions of the track typically is relatively large. This causes a need for the extrusion die to be of relatively long length. Longer dies have been found to create problems in the manufacture of double walled tubing such as high head pressures and/or uneven distribution of the extruding plastic. Furthermore, long die lengths reduce the potential selection of materials to be utilized which could otherwise be utilized with shorter die lengths.

A need exists to utilize materials such as polyvinylchloride (PVC). Polyvinylchloride (PVC) requires a shorter die length than is available in many prior art corrugators.

When constructing some prior art corrugators, a mold chain length has been fixed. If a customer has a special product, or wants to increase or decrease the length of the machine, the customer could typically expect extensive modifications to be required and performed upon that particular corrugator. Today, there is a high demand for greater and greater speed which often results



in longer and longer forming tunnels. For instance, when a 20-foot mold section was once found adequate, a consumer now may desire a 40-foot mold section. This modification may be extensive and require a lengthy down time for the machine.

## SUMMARY OF THE INVENTION

5           The present invention recognizes and addresses the foregoing disadvantages, and others, of prior art construction and methods. Accordingly, it is an object of the present invention to provide an improved machine, such as a corrugator, for making plastic tubing or other formed plastic product. A trackway defining a continuous path and a plurality of carriages for carrying mold blocks about the continuous path are utilized. Each of the carriages transports at least one pair of mold blocks which are linearly displaceable from one another. In a closed configuration, a first and second pair element of a pair of mold blocks engages with one another along a molding section of the continuous path to form an axial portion of a mold tunnel in the molding section. Using the linear closing mechanism, the molds may be operated on a continuous path which has a quick, i.e., smaller, entrance radius. A small entrance radius in a continuous path allows for extrusion dies to be shortened. With a die of shorter length, the traditional problem of die length is reduced. Accordingly, rapidly solidifying materials such as polyvinylchloride (PVC) may be utilized to make corrugated tubing.

          The mold blocks open and close preferably using a non-hinged carrier. This carrier is comprised of a main plate with two linear slot bearings which are mounted in a manner to allow the mold to open evenly away from the product. Accordingly, the carrier need not hinge away from itself.

20       The linear non-hinged mold carrier, is preferably composed largely of "off-the-shelf" components which may provide for quick field repairs without the need to remachine mold locating surfaces. Furthermore,

the radius and angle of curvature of the continuous track may assist in correct positioning of opposing mold blocks when forming the mold tunnel without having mold surfaces wear against one another.

The mold blocks may be balanced by use of sprockets and chain. Movement of one block may drive the opposing block in a similar fashion (i.e., inward or outward). The balanced design is believed to assist in prolonging the life of components and may assist in faster production rates due to lower power consumption.

In an alternative embodiment, linear motors operate in conjunction with programmable logic controls to engage a select number of carriages at the beginning of the mold tunnel to continuously drive the carriages along the mold tunnel. The linear motor working with programmable logic controls is also able to shuttle carriages which are not in the mold tunnel along portions of the continuous path at a higher rate of speed than the speed of the mold blocks along other sections of the continuous path. Linear motors may be used independently of mechanical drive mechanisms such as gear boxes, chains, transmissions, and the like. The linear motor may accelerate a carriage which leaves the mold tunnel, shuttle the out-of-service mold block through a second section of the continuous path, decelerate the carriage prior to the beginning of the mold tunnel and maintaining a predetermined speed, speeds, and/or positions through the mold tunnel. The more preferable method of moving the carriages is to use a drive rod and sprocket to drive at least one at a time with the driven carriage pushing the others about the continuous loop.

The mold block may be utilized in conjunction with a vacuum machine for molding tubes. In a preferred embodiment, the tube product is corrugated. The mold block is preferably adapted to moving about an endless path and cooperates with other blocks to define a molding tunnel with a

vacuum source along a portion of the path. In an alternative embodiment, at least two molding tunnels may be formed at two different portions of the continuous path.

The mold blocks may include a plurality of sub-blocks secured end to end. Each sub-block has a face arcuate about a longitudinal axis and corrugated with at least one complete wave length of circumferential grooves and lands. A vacuum channel within the mold block provides access from a vacuum source to the interior portion of the mold. The vacuum passage is connected to a vacuum source at a vacuum interface as the mold block passes along the mold tunnel. The vacuum interface in the molding section or sections preferably utilizes a cushion. This cushion may be pneumatic or mechanical such as springs and allows for the interface to adjust as the forming molds thermally expand without binding or leakage.

The corrugator utilizes at least one molding section and may include a shuttle section. In a transition section, a one or more tracks direct the mold carrier and the mold blocks to a closed position where they are maintained through a molding section. A second transition section contains one or more tracks which may assist in guiding the mold blocks to an open position to allow the extruded product to be removed. Preferably, the track(s) and rollers prevent "sawtoothing" by properly aligning a pair of mold blocks in a closed configuration during the molding section.

Preferably the machine is constructed in a horizontal fashion instead of a vertical planer fashion such that the molds move in a horizontal fashion. The vertical profile is lowered by not having two mold sets one above another. Furthermore, the shorter profile allows easier accessability to the molds and carriers for maintenance and changeover. Horizontal design may also allow for increasing production requirements. If a continuous mold chain is utilized instead of shuttling the molds at a high

rate of speed in nonforming sections, it is possible to mold corrugators in two directions. Accordingly, a single corrugator could have output coming from at least a first mold tunnel and a second mold tunnel. Another advantage of the horizontal design is the ability to quickly change mold blocks in the carriers which allows a single corrugator to manufacture a plurality of different products by swapping out the mold blocks on the carriers.

The mold blocks may be cooled in a number of ways. The traditional water cooling techniques may be utilized. Ambient air cooling, such as may be achieved by passing the open mold blocks through space when not molding, may also be utilized. If this cooling is not sufficient alone, forced air cooling may also be utilized. One method of forced air cooling includes the use of vortex nozzles. The vortex nozzles may be mounted in locations which allow for optimum thermal transfer of heat away from the mold. Utilizing cooling vortex nozzles, the traditional method of water cooling within the mold blocks may be eliminated.

A second method of cooling which may be utilized includes spraying the mold blocks with a solution (such as water or an evaporable solution). Using this second method, the thermodynamics of the heat of vaporization of the evaporating substance is utilized to increase the efficiency of the cooling process.

The corrugator of the preferred embodiment is also modularly constructed in sections. These sections interlock with one another. Accordingly, a single carrier design may be utilized regardless of a particular configuration length needed. A machine may be taken apart at a location, section(s) inserted, and the machine reconnected with the new section installed. In this manner, a single machine may be configured for different lengths or types of products. Modifications may be performed in a short period

of time. Also, parts of like machines can be interchangeable. Furthermore, machines may be combined in tandem for ultra high-speed production and then separated for standard rate production. Modularity is also an advantage as components can be sold directly to the customer for in-house changes. Modularity allows for higher volume production of like parts which may reduce the individual part costs.

Additional objects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description or accompanying drawings, or may be learned through the practice of the invention.

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate several embodiments of the invention and together with the description, serve to explain the principles of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

A full and enabling disclosure of the present invention, including the best mode thereof and directed to one of ordinary skill in the art, as set forth in the specifications, which makes reference to the appended drawings in which:

Fig. 1 is a top diagrammatic view of a mechanically driven embodiment of the invention;

Fig. 2 is a top plan view of an alternative embodiment of the invention driven by linear motors;

Fig. 3 is a detailed side plan view of a preferred mechanically driven embodiment of the invention with only tow mold block assemblies shown;

Fig. 4 is a side diagrammatic view of the machine of Figure 3 illustrating the formation of a mold tunnel by a plurality of closed mold block assemblies;

Fig. 5 is a front plan view of the machine of Figure 4 taken along the line A-A showing a mold block in the open position, and a mold block in the closed configuration;

Fig. 6 is a detailed front plan view of the machine of Figure 3 showing mold blocks of two different sizes; and

Fig. 7 is a side view of a mold block assembly of the preferred embodiment with the mold blocks removed;

Fig. 8 is a top plan view of an alternative configuration showing the use of two extruders;

Fig. 9 is a side plan view of a portion of the mold block assembly of Figure 7 with a first mold block half installed;

Fig. 10 is a side plan view of a portion of the mold block assembly of claim 7 with a larger mold block half installed;

Fig. 11 is a top plan view of the mold block assembly of Figure 7 showing two top mold block halves mounted in a single carrier; and

Fig. 12 is a side plan view of a portion of the mold block assembly of Figure 7 with an adapter mounted with a quick release mechanism.

Repeat use of reference numerals in the present specification represent like, similar or analogous parts, structures or elements of the present invention throughout several views.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made in detail to the presently preferred embodiments of the invention, one or more examples of which are illustrated in the accompanying drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be

apparent to those skilled in the art that modifications and variations can be made in the present invention without departing from the scope or spirit thereof. For instance, features illustrated or described as part of one embodiment may be used on another embodiment to yield still a further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

Referring to Figure 1, a machine **10**, in the form of a corrugator is illustrated. The machine **10** is cooperable with a first extruder **12** to continuously mold an extrudable material such as a plastic. The machine **10** utilizes at least one continuous path **14** which is preferably located on machine **10**. A plurality of separate carriages **16** carry mold blocks about the continuous path **14** of said machine **10**. Each of the carriages **16** carries at least one pair of mold blocks, illustrated as mold block pairs **18**. The mold block pairs **18** are displaceable from one another and are capable of mating engagement with one another along a molding section **20** of the continuous path **14**. When the mold block pairs **18** are in mating engagement with one another and closed to form a mold tunnel, plastic may be molded within to form piping **22** or other products. The mold blocks move along the continuous path **14** to enter the molding section **20** at its beginning **24** and exit at the molding section end **26**. The preferred method of driving the carriages **16** about the continuous paths **14** is to utilize a drive shaft **28** with spokes **30** which engage at least one carriage **16** at a time. Since adjacent carriages **16** are substantially adjacent to one another in the preferred embodiment, all of the carriages **16** may be moved by driving one or more of the carriages **16**.

In an alternative embodiment, the machine **10** may utilize a linear motor drive system as shown in Figure 2 which has at least one stator **32** which is located proximate to the continuous path **14**.

Rotor elements **34** which are connected to the carriages **16** in this embodiment. In some embodiments, it may not be necessary to have a rotor element **34** on every carriage **16**, however, the embodiment illustrated in Figure 2 has rotor elements **34** on every carriage **16**.

If linear motors are utilized, multiple stators **32** may be required to propel the carriages **16** at different speeds along the path **14**. A control device **38** may be connected to a plurality of stators **32** to achieve the desired changes of speeds in different locations. Furthermore, sensors **40** may also be utilized along the continuous path **14** or at other locations to monitor position of carriages **16** and mold block pairs **18** (collectively referred to as mold block assemblies **36**) and provide information to the controller **38**.

By using a higher speed at portions of the continuous path **14** where a particular mold block pair **18** is not in use in a molding section **20**, the carriage **16** may be shuttled to another portion along the continuous path **14**. This process would allow for fewer mold block pairs **18** and mold block assemblies **36**. Fewer mold block pairs **18** and mold block assemblies **36** could result in a lower cost of the overall machine **10**.

Also in the alternatively preferred embodiment illustrated in Figure 2, connectors **42** link the control device **38** to stators **32**. Furthermore, the control device **38** may incorporate an electronic power supply device, and a computer or controller, which may generate appropriate signals to the stator **32**. The signals may be the driving force which propels the mold block assemblies **36** around the continuous path **14**. Accordingly, the requirement for mechanical drive devices such as chains to propel the mold block assemblies **36** around the continuous loop **14** may be eliminated in this embodiment. The positioning of connections **42** allows for the speed of the mold block assemblies **36**



to be adjusted at different locations along the continuous path **14**. Other locations and connections **42** may be necessary or desired for particular applications. The control device **38** utilized to control the speed of the mold block assemblies **54** preferably uses “quick carrier return technology” which allows for the shuttling carriages **16** of unused mold blocks pairs **16** at a higher rate of speed relative to the progress of mold blocks pairs **18** through the mold tunnel **20**.

Referring back to Figure 1, the machine **10** also has a vacuum system which is supported by a vacuum support **44**. The vacuum support **44** houses a plenum which connects a vacuum source to a vacuum interface. Figure 1 also shows a cooling technique using a mister **46** and blower **48**. Other details of the vacuum system and cooling technique will be discussed below.

The machine **10** is constructed in a modular fashion. Figure 3 illustrates the frame **50** of the machine **10** in two sections: first frame section **52** and second frame section **54** connected at interface **56**. First frame section **52** may be disconnected from second frame section **54**, the two spread apart and a third frame section may be inserted to make the machine **10** larger. In the alternative embodiment of Figures 2 and 4, a third frame section **58** and fourth frame section **60** are illustrated as having widths from only about half that of a single mold block assembly **36** up to that of about three mold block assemblies **36** and are connected at junction **62**. Utilizing smaller frame sections **58**, **60** may allow for more precise sizing of the continuous path **14**. Furthermore, as shown in Figures 1 and 2, a frame section **58** may include first and second frame sub-sections **64**, **66**. Sub-sections **64**, **66** together include an entire width of the machine **10**. The sub-sections **64**, **66** meet at interface **68**. First, second, or fourth sections **52**, **54**, **60** may also be comprised of such sub-sections which permit the width of the machine **10** to be adjusted by the use of varied width subsections or spacers between

subsections. Accordingly, frame sections **52, 54, 58, 60** may be as large or as small as needed for a particular application and make the modular machine **10** easier to adapt to a particular need.

Furthermore, as illustrated in Figure 3, the machine **10** may be disconnected at connection **70** and raised in the vertical direction to accommodate taller carriages **16** or for other modification reasons.

In Figures 1 and 3, first and second sections **52, 54** could be disconnected at interface **56** in order to lengthen the machine **10**. Accordingly, two continuous path portions of the first and second sections **52, 54** and an inserted section (not shown) would form a new longer the continuous path **14**. Alternatively, in the embodiment illustrated in Figures 1 and 2, other portions or sections of the machine **10** may be removed to allow for shortening of the machine **10** to accommodate a shorter mold tunnel **20** if desired. By utilizing this manner of modular construction, the length or shape of the continuous path **14** of the machine **10** may be adjusted.

The continuous path **14** of the machine **10** is preferably constructed in an oval shape. This shape has been found to minimize the space required by the machine **10**. Other configurations may also be constructed. Sections of the continuous path **14** of the frame **50** and the oval configuration illustrated in Figure 1 have curved portions such as curved portion **72**. Curved portion **72** may have a semicircular or other curved shape to transition the continuous path **14** from a first linear section **74** to a second linear section **76**. The curved section **72** may be utilized by itself or in conjunction with other curved sections **72** to transition a first linear section **74** of the continuous path **14** to a second linear section **76** of continuous path **14**. The preferred connection system for different portions of the frame **50** is to utilize releasable connectors at the interfaces or junctions of the frame sections. Pins and bores

may be suitable connectors. A pin may be anything which fits within a cavity of the frame **50** such as a bolt or dowel.

Details of the machine **10** have been omitted from many of the figures in order to clearly illustrate the invention. However, it should be understood that such details are not directly relevant to the concept of the present invention, and that different types of machines could also incorporate the present invention. For example, when the illustrated embodiment uses a vacuum to conform an extrudable material, such as plastic, to the mold blocks as described in detail hereafter, the present design could be used with different mold blocks, etc., or could even be used with a corrugator structure which uses different means, such as internal pressure, to conform the plastic to the mold blocks.

In the alternative embodiment of Figure 5, the mold block assemblies **36** are illustrated as being driven about a path in the form of a trackway **78**. The trackway **78** is preferably horizontally oriented, that is, the mold block assemblies **36** are carried by the trackway **78** for movement in a substantially horizontal plane (i.e., parallel to the floor where the machine **10** is located). The trackway **78** of the preferred embodiment is illustrated in Figures 3 and 5. The trackway **78** provides a support for the carriages **16** as they traverse about the continuous path **14**. It is preferred that the trackway **78** support a large portion of the weight of the carriages **16** which is believed to assist in extending the longevity of the machine **10** while providing for faster rates of production. Additionally, the two sizes of mold block pairs **18**, **80** illustrated in Figure 3 are for illustrative purposes. Although different size mold blocks **18**, **80** could be utilized during product formation, a transition between sizes would be required. For the production of corrugated piping, mold block pairs of a single size are typically utilized.

An extruder **12** is provided adjacent to the beginning of the mold section **20** and, in the alternative embodiment of Figure 8, extruders **12, 82** are provided for the machine **10** and two mold tunnels: a first mold tunnel **20** and a second mold tunnel **84**. These two mold tunnels **20, 84** have extruders **12, 82** adjacent thereto. The extruder **12** or extruders **12, 82** may or may not be connected to the frame **50** in some manner.

It is contemplated that at least portions of an extruder **12** may be moved back and forth toward and away from the beginning of the associated mold section **20**. For instance, as illustrated in Figures 3-6, the frame **50** may include rollers **86** which allow the machine **10** to be moved relative to a stationary extruder **12**. In the preferred embodiment, the rollers **86** are located on one or more tracks **88** which allow a single operator to move the machine **10** relative to the extruder **12**. Movement of the machine, or an extruder **12** may be necessary during start up and shut down of the machine **10**. Alternatively, moving portions of an extruder **12** or frame **50** may be necessary for maintenance.

In most applications, the material to be extruded, normally a plastic, is heated to the desired temperature and forced into the nozzle of the extruder **12**. The machine **10** is then rolled into position with the extruder nozzle extending into the mold tunnel **20**. A plurality of adjustment mechanisms **90** preferably operated by cranks **92** are utilized to provide for precise positioning of the machine **10** relative to the extruder **12**. Cranks **92** are preferably hand wheels, but automated equipment could also be utilized such as electric servos or stepper motors, especially if the machine **10** is equipped with a sophisticated control device **38** that may also control these motors. Care should be taken for the extruder nozzle to not contact the mold blocks **18** in the mold tunnel **20** during extrusion as aluminum mold blocks **18** would be easily damaged. Accordingly, the adjustment mechanisms **90** allow for very

precise adjustment of the mold tunnel **20** relative to the frame **50**. Specifically, the adjustment mechanisms **90** may allow for in excess of two inches of movement vertically at either end of the frame **50** in very minute increments as well as in excess of two inches of movement laterally at the mold tunnel beginning **24** and end **26**. Stops **94** illustrated in Figure 3 are utilized to located the machine **10** relative to the extruder nozzle, and adjustment mechanisms **90** are also utilized to adjust the distance of the mold tunnel beginning **24** from the extruder nozzle.

Figure 6 shows the vacuum frame **44** supports ducts **45** which are provided along the mold tunnel **20**. The ducts **45** communicate with a manifold **47** in the mold block pairs **18** as described hereafter to draw a vacuum around the outside of the extruded material in the molding sections **20**.

A plurality of mold block assemblies **36** are supported and guided by the trackway **78** for rolling action thereon. Preferably, all mold block assemblies **36** are alike on any particular machine **10**.

Regarding the mold assembly **36** of the embodiment shown in Figure 5, each mold block assembly **36** has a carriage **16** which supports the pair of mold blocks **18**. The carriage **16** is supported on rollers **98, 100** which may be a portion of the carriage **16** or may be a portion of the trackway **78**, as illustrated in this embodiment. Additional support for the mold block assemblies **36** may be provided by rollers **102, 104**. Furthermore, raceways, tracks or bearings **106** may be utilized to maintain the carriage **16** in its proper location along the trackway **78**. The rollers **98-104** and bearings **106** may be utilized to enable the mold block assemblies **36** and more particularly the carriages **16** to roll along the trackway **78** without derailing or excessive resistance.

To maintain the mold block pairs **18** of the mold block assemblies **36** in alignment and to assure that the carriages **16** roll properly within the trackway **78**, raceways **108-118** are provided along the

trackway **78**. The raceways **108-118** assist in the opening and closing of the mold block pairs **18**. The mold block pair **18** has a first mold half **120** and a second mold half **122**. The first and second mold block halves **120, 122** are substantially mirror images of each other, and each is an open ended semi-cylinder having a corrugated inner wall formed by alternating grooves and lands.

Referring back to Figure 5, the mold block pair **18** on the left is closed as it is positioned while in molding section **20** and forms internal passage **202**. Rollers **102, 104** are contacting raceways **108, 110** which assist in maintaining the mold block halves **120, 122** next to one another. The mold block pair **18** on the right is open. Raceways **112-118** are further apart than raceways **108, 110** and maintain the block halves **120, 122** in an open configuration relative to one another. Referring to Figures 3 and 4, transition segments **130-136** move the mold block pairs **18** or **80** relative to the carriage **16** by acting on rollers **102, 104**.

As a mold block pair **18** enters transition segments **130, 132** (from left to right in Figure 4) the rollers **102,104** direct the mold blocks to move from the open position illustrated to the far left to a closed position as illustrated along mold tunnel **20**. At the end of the mold tunnel **20**, transition segments **134,136** act on rollers **102,104** to direct the mold blocks to an open position as illustrated on the far right, thereby allowing product to be removed from the machine **10**.

The mold frames, or holders **138, 140** are connected to a linear guide segment **142** with bearings, such as linear bearings **168** so that the mold halves **120, 122** open and shut at the transition sections **130-136** as illustrated in Figures 3 and 4. In the preferred embodiment, the transition segments **130, 132** include a portion of the curved segment **72** at the ends of linear segments **74,76**. In fact, although the majority of the curved segment **72** may have a relatively small radius such as about

two or three feet, it has been found helpful to have a large radius, such as about twenty to twenty five feet at or near end portions of the transition segments **130, 132** so that adjacent mold block pairs **18** come together without imposing substantial wear on the touching end portions of adjacent mold blocks as they contact to form the molding section **20**. Utilizing the linear travel of the mold block halves **120, 122** to close, the radius of curvature in the curve portions of the frame **50** may be made smaller than is common in the prior art for hinged type mold blocks. The use of raceways **130, 132** to close the mold block pairs **18** from an open position allows for a relatively quick closing of the mold blocks **120, 122**. Accordingly, by reason of the shorter radius of curvature and quicker closing, a shorter die may be utilized. A shorter die allows the use of rapidly setting materials such as polyvinylchloride (PVC) which have not traditionally been deemed suitable in these machines **10**. Other methods may also be utilized to open and close the mold block halves **120, 122**, instead of or in addition to raceways **108-118** acting on directors or rollers **102, 104**.

Referring to Figures 6 and 7, the mold block assembly **36** has carriage **16** which includes rollers **104, 106** for cooperating with trackway **78**. Although only two rollers **104, 106** are shown in Figure 6, it is anticipated that four or more rollers **104, 106** will be utilized with each assembly **36** in order to provide more stability to the assembly **36** along the trackway **78** as illustrated in Figure 7. The rollers **104, 106** are preferably eccentric cam rollers, like almost all of the rollers in the preferred machine **10**, which allow for precise adjustment of the rollers **104, 106** to ensure that the assembly **36** is balanced and properly oriented to reduce vibrational tendencies and move the mold block pairs **18** in a smooth fashion through the continuous loop **14**.

Referring to Figure 6, rollers **148-154** are located on the ends of the carrier **16** to cooperate with runs **107, 108**, or raceways in a slightly different fashion than shown in Figure 5. These rollers **148-154** maintain the carrier **16** in the runs **107, 108** and assist in moving the assemblies **36** about the continuous path **14**. Additionally, in the preferred embodiment, two of each of the rollers **148-154** are utilized to assist in stabilizing the carrier **16**.

The assembly **36** is illustrated in Figure 7 without the mold block halves **120, 122** and in an open position. An upper and a lower mold holder **138, 140** are spread apart, in an open position. The upper and lower mold holder **138, 140** may be a portion of the mold block halves **120, 122**, or more preferably, an element with connectors to hold a mold block half **120, 122** thereto. A mold block frame **160, 162**, shown in Figure 6, may be necessary in some embodiments to connect the holder **138, 140** to the mold block halves **120, 122**. A plurality of different embodiments are illustrated in Figures 9-12 illustrating different configurations of mold block halves **120, 122** and frames **160, 162**.

Referring back to Figure 7, the preferred embodiment includes connected upper and lower holders **138, 140** through a coupling such as a sprocket **164** connected to a chain **166**. The holders **138, 140** have linear bearings **168** which cooperate with linear guide **142** which assist in the opening and closing of the mold halves **120, 122**. In the illustrated embodiment, the coupling connects the movement of the halves **120, 122** so that when one of the two holders **138, 140** is moved either inwardly or outwardly, the other holder **138, 140** will move in a similar fashion (inwardly or outwardly). A linkage arm **170** allows for adjustment of the amount of tension of the chain **166**. Gravity acting on the lower holder **140** will tend to keep the two holders **138, 140** apart unless the top holder **138** is driven inwardly by the roller **102** riding through the transition **130**. This will drive the upper holder **138**



inwardly, toward a center of the carrier **16**. The chain and sprocket system will pull the lower holder **140** inwardly as well. This brings the facing surfaces **121, 123, 125, 127** of the mold block halves **120,122** together. The lower transition raceway **132** and roller **104** may not be necessary in all embodiments as a result of the chain **166** and sprocket **164** system, however the lower roller **104** and transition raceway **132** are utilized in the presently preferred embodiment.

Figures 9-12 show the mold block assembly **36** in more detail. The rollers **148,152** travel along tracks or raceways **156**, shown in Figure 6. The roller **102** is located in mold positioning raceways such as transitions **130-136** shown in Figure 3, which assist in opening and closing the mold block holders **138, 140**. The transitions **130-136** and raceways **108-118**, also shown in Figures 3 and 5, determine the position of the mold blocks **120, 122** relative to one another as a particular carriage **16** travels around the continuous path **14**. Linear bearings **168** slide on guides **142** to allow vertical movement of the mold block pairs **18**.

Figure 9 shows a first mold block **172** with a two arms **174, 176** comprising the frame **160**. The arms **174, 176** connect the mold block **172** to the holder **138** at connections **178, 180**. Connector **180** is a dovetail to dovetail slide fit while connector **178** is preferably a bolt or other connection. By removing connector **178**, the friction fit of connector **180** is relieved and the mold block **172** may be pulled up and off the holder **138**.

Figure 10 is a mold block assembly **36** with an alternative mold block **182**. Due to the size of this mold block **182**, the connectors may restrain the mold block **182** without the need for a frame **160** as arms **174, 176** as illustrated in Figure 9. Obviously a larger diameter corrugated pipe product may be manufactured with the mold block **182** of Figure 10 than with the mold block **172** of Figure 9.

Figure 12 is a mold block assembly 36 with an adapter 184. The adapter 184 may be a portion of frame 160 and has a release lever 186 instead of connection 178 in order to assist in connecting a third mold block design 188 to the holder 138. The mold block 188 connects to the adapter 184 at connections 190, 192 which may, or may not be similar to connections 178, 180 of Figure 9. The adapter 184 connects to the holder 138 at connections 180, 194 and release arm 186 may allow for rapid removal of block 188. The release 186 is designed to allow rapid replacement of mold blocks, as for instance, any of mold blocks 172, 182, 188 with other mold blocks so that a single machine 10 may be utilized with a variety of blocks by the manufacturer. Instead of needing two machines to make two different size or type products, a single machine 10 with multiple sets of mold blocks, such as blocks 172, 182, 188 may be utilized. Almost any mold block pair of any manufacturer may be configured with an adapter 184 for use with the machine 10 of the preferred embodiment.

Figure 11 is a top view of Figure 12. Two or more blocks 188 may be utilized with a single mold block assembly 36 depending on the width of each pair of mold blocks 188. For larger and wider blocks 182, one pair of blocks per assembly 36 would likely be more common. Common sizes are four inch widths and eight inch widths. When constructing blocks 18 in standard size widths, one will see the versatility of being able to quickly swap out mold blocks of different sizes in rapid order, a feature of at least some embodiments of the present invention. One machine 10 can be modified in a relatively small period of time to change the product produced.

Figure 11 also shows the relationship of receiver walls 196, 198 which bound a receiver 200 of the mold block assembly 36. This receiver 200 accepts the spoke 30 connected to the drive shaft 28

(shown in Figure 1) when at the correct position in the continuous path 14. The drive shaft 28 and spokes 30 illustrated in Figures 1 and 6 to move the mold block assemblies 36 about the continuous path 14. Electric motor 128 drives the drive shaft 28 which moves the spokes 30. The spokes 30 cooperate with the receivers 200 (illustrated in Figure 11) in the mold block assemblies 36 to move at least one assembly 36 at a time. Since the preferred embodiment includes a continuous chain of assemblies 36, the driven assemblies 36 push the non-driven assemblies 36 about the continuous path 14.

Alternatively, each mold block assembly 36 may have a rotor 34 of a linear motor connected, integrally or otherwise thereto on the carriage 16. The rotor 34 acts in conjunction with the stator 32 in order to drive the mold block assembly 36 along a continuous path 14 and trackway 78. Other connections for the rotor 34 to the mold block assembly 36 could also be used.

As is shown in Figure 5, the mold block halves 120,122 include a passageway for connecting the internal mold tunnel 202 with the vacuum manifold 96, the passageway normally defined by a plurality of slits in the lands intersecting axial bores in the mold blocks 120,122 where the bores are connected by an annular groove 119 in the mold blocks 120,122. The vacuum manifold 96 connects with vacuum interface 204 which is preferably attached to vacuum manifold 96. The vacuum interface 204 is preferably mounted with a cushion such as pneumatic cushion 206. Other cushioning devices such as spring type mechanisms could be utilized to maintain the vacuum interface 204 in contact with the vacuum manifold 96 of the mold block pair 18 in the molding section, 20. The pneumatic cushion 206 is able to adjust to expansion of the mold block pair 18 without binding or leakage. Furthermore, the pneumatic cushion 206 may adjust for other movement of the vacuum manifold 96. The vacuum

cushion **206** need not be located upstream of the vacuum interface **204** but could even be incorporated as part of the vacuum interface **204**. Preferably, the vacuum frame **44** supports the cushion **206**, the vacuum interface **204** and the manifold **96**. An internal portion of the vacuum frame **44** provides a channel or duct **45** for connecting a vacuum source (not shown) to the vacuum interface **204**. In this manner, a vacuum may be drawn in the mold tunnel **202**.

It should be understood, however, that still other mold block structures could be used within the scope of the present invention. For example, other air and vacuum systems both internal and external of the mold blocks could be utilized such as those taught by U.S. Pat. Nos. 5,257,924; 4,718,844; and 5,059,109.

As shown in Figure 2, cooling of mold blocks **18** may be accomplished by cooling nozzles **208** positioned around the mold block assemblies **36** or even within the frame **50** to cool mold block pairs **18**. The location of the cooling nozzles **208** are in areas such that the mold block pairs **18** may be reduced in temperature by blowing forced air on the mold blocks **18** at specific locations. A single cooling nozzle **208** may be utilized or multiple cooling nozzles **208** may be utilized at various locations. A sufficient quantity of cooling nozzles **208** may be employed to cool the mold blocks **18** so that internal cooling water systems of the mold blocks is not necessary. This significantly reduces the cost and complexity of mold block assemblies **36** and mold blocks **120,122**. Other cooling air systems such as the system taught in U.S. Pat. No. 5,257,9924 could also be utilized.

Another method of cooling which may be utilized is shown in Figure 1 and includes spraying the mold blocks with a solution (such as water or an evaporable solution) with mister **46**. It is preferred that external portions of the mold blocks **18** be sprayed with in relatively small amounts of solution.

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The liquid may be heated to bring the liquid closer to the temperature where it would evaporate or turn into a gaseous form. As the solution evaporates, a large amount of energy in the form of heat is removed from the mold blocks **18**. Since most mold blocks **18** are aluminum, the heat quickly transfers from the hotter internal portions of the mold block **18** to the external sprayed portions for energy removal. A vent **48** including a blower may be utilized to direct the high moisture air away from the work area to maintain a proper level of moisture content in the ambient air. This reduces the likelihood of rusting other portions of the machine **10**. Additionally, additives may be added to the solution, including oils, to reduce the possibility of rust. Using this evaporative cooling method, the thermodynamics of the heat of vaporization of the evaporating substance is utilized to increase the efficiency of the cooling process. The vertical orientation of the mold blocks **120,122** facilitates spraying the external surfaces with an evaporating solution without contaminating the internal molding surfaces.

Numerous alternations of the structure herein disclosed will suggest themselves to those skilled in the art. However, it is to be understood that the present disclosure relates to the presently preferred embodiments of the invention which are for purposes of illustration only and not to be construed as a limitation of the invention. All such modifications which do not depart from the spirit of the invention are intended to be included within the scope of the appended claims.

We claim:

1. A machine cooperable with an extruder to continuously mold an extrudable material comprising:  
  
a continuous trackway;  
  
a frame supporting the trackway;  
  
a plurality of separate mold block assemblies restrained to travel about said trackway;  
  
and  
  
at least one pair of mold block halves connected to each of said plurality of mold block assemblies, said mold block halves linearly displaceable from one another and capable of mating engagement to form a mold tunnel.
2. The machine of claim 1 further comprising a linear motor drive system having at least one stator located proximate to the trackway and at least one rotor element connected to at least one of said plurality of mold block assemblies.
3. The machine of claim 1 wherein each the mold block assemblies further comprise a carriage, a guide, and mold block holders, said holders connected to opposing halves of said at least one pair of mold block halves, said carriage restrained to travel substantially about said continuous path, and said guide operatively connecting the holders to the carriage while allowing linear reciprocating movement of the holders relative to the carriage.

4. The machine of claim 3 further comprising a bearing coupling the mold block holder to the guide.
5. The machine of claim 4 wherein the bearing is a linear bearing.
6. The machine of claim 2 further comprising a control device for controlling the speed of the carriages along a portion of the continuous path.
7. The machine of claim 6 wherein the control device comprises a programmable logic control device.
8. The machine of claim 6 wherein the control device provides at least one signal to the linear motors operating on at least two of said plurality of carriages to propel the two carriages at different speeds.
9. The machine of claim 1 further comprising a plurality of raceways adapted to contact a director, said director connected to at least one of said mold block halves, said raceways locating said mold block halves relative to one another.

10. The machine of claim 3 further comprising a plurality of raceways and at least one director, said raceways locating said mold block halves relative to one another, and said director connected to at least one of the holders.
11. The machine of claim 1 wherein the continuous trackway is substantially oval shaped.
12. The machine of claim 1 wherein the frame is modularly constructed and comprised of a first section and a second section connected at an interface, and said first and second sections having first and second portions of said trackway.
13. The machine of claim 1 wherein the plurality of mold block assemblies substantially abut one another about the continuous path.
14. The machine of claim 1 further comprising a drive rod mechanically adapted to engage at least one of the mold block assemblies at a location about the continuous path to move the assemblies about the continuous path.
15. The machine of claim 1 wherein the frame sits upon rollers and the frame is moveable between at least two positions.
16. A machine cooperable with an extruder to continuously mold a product comprising:



a continuous path;

a plurality of mold block assemblies restrained to travel about said continuous path, each of said mold block assemblies having a carriage moveable about said path and at least one pair of mold block halves mounted upon each of the carriages, said mold blocks halves oriented to oppose one another, and being linearly displaceable relative to one another, and capable of mating engagement with one another along a molding section of the machine to form a mold tunnel within which the product may be molded.

17. The machine of claim 16 wherein the continuous loop is substantially oval shaped.
18. The machine of claim 16 having at least two molding sections.
19. The machine of claim 16 further comprising at least one cooling nozzle directing compressed air towards at least one of the mold block halves.
20. The claim of claim 19 whereby said cooling nozzle is a cooling vortex nozzle.
21. The machine of claim 16 further comprising a cooling system having a mister and a vent, said mister directing a liquid to deposit on a surface portion of at least one of the mold block halves of at least one of the mold block assemblies, said vent adapted to

assist in evaporating at least some of the liquid deposited on said surface portion of the  
at least one mold block half.

22. The machine of claim 21 wherein the vent is coupled to a blower.
23. The machine of claim 21 wherein said liquid is a temperature above room temperature prior to directing towards the mold block half.
24. The machine of claim 21 wherein the vent is spaced apart from the mold block halves.
25. The machine of claim 16 wherein the carriage is coupled to rollers restricted by a trackway to operate in the continuous loop.
26. The mold block assembly of claim 25 wherein the rollers at least assist in carrying the weight of the mold block assembly.
27. The mold block assembly of claim 26 further comprising a director connected to at least one of the holders and said director adapted to cooperate with a raceway of the machine to locate a given pair of mold blocks relative to one another.

28. A cooling system for use with an extruder and a plurality of mold block halves, said system comprising:
  - a mister directing a liquid to deposit on a surface portion of at least one of the mold block halves; and
  - a vent adapted to assist in evaporating at least some of the liquid deposited on said surface portion of the at least one mold block half.
29. A mold block assembly for use with an extruder and a machine with plurality of pairs of mold block halves operated in a continuous loop, said mold block assembly comprising:
  - a carriage, a guide, and a first and a second mold block holder, said first holder connected to a first half of a mold block pair, said second holder connected to a second half of the mold block pair, and said guide operatively linking the first and second holders to the carriage and allowing linear displacement of the first and second mold block halves relative to one another.
30. The mold block assembly of claim 29 further comprising an adapter connected to said first holder and said first mold block.
31. The mold block assembly of claim 30 further comprising a release lever, said release lever having a first position connecting the adapter to the first holder and a second position releasing at least a portion of said adapter from said first holder.

32. The mold block assembly of claim 29 further comprising a coupling connecting to the first and second holders, wherein movement of the first holder relative to the carrier in a direction moves the second holder relative to the carrier.
33. The mold block assembly of claim 32 wherein the coupling further comprises a sprocket rotatable relative to and connected to the carrier, and a chain connected to the first and second holders, said chain contacting the sprocket wherein movement of the first holder relative to the carrier moves the chain and the second holder.
34. The mold block assembly of claim 32 wherein movement of the first holder towards a center portion of the carrier moves the second holder toward the center of the carrier.
35. The mold block assembly of claim 29 wherein the holders are adapted to receive at least two different sized mold block halves.
36. The mold block assembly of claim 29 wherein the first and second holders are connected to at least two halves of two mold block pairs.
37. A method for producing an extruded product utilizing a machine having a continuous trackway configured in a continuous path, a frame supporting the trackway, a plurality of separate mold block assemblies restrained to travel about said trackway; and at least

one pair of mold block halves connected to each of said plurality of mold block assemblies, said mold block halves linearly displaceable from one another and capable of mating engagement to form a mold tunnel therein, said method comprising the steps of:

forming a mold tunnel along a portion of said continuous path;

extruding an extrudable material within the mold tunnel; and

linearly displacing mold block halves at an end of the mold tunnel to allow the extruded product to be removed from the machine.

38. The method of claim 37 further comprising the step of cooling the mold block halves after removing the extruded product from the machine.

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## ABSTRACT

A method and apparatus for producing an extruded product includes a machine that cooperates with an extruder. The machine is commonly used as a corrugator and the extruded product is often corrugated piping. The machine has a frame supporting a trackway in a continuous path. A plurality of mold block assemblies travel about the continuous path to form a mold tunnel along a portion of the continuous path. The mold block assemblies include a carriage connected by at least one guide and linear bearings to a pair of mold holders. The mold holders are connected to at least one pair of opposing mold blocks. Guides and directors position the mold block pairs relative to one another while the assemblies travel along the continuous path. As the holders, and thus the mold block halves, are linearly displaceable from one another, the halves may meet to form the mold tunnel and separate to allow removal of the extruded product.

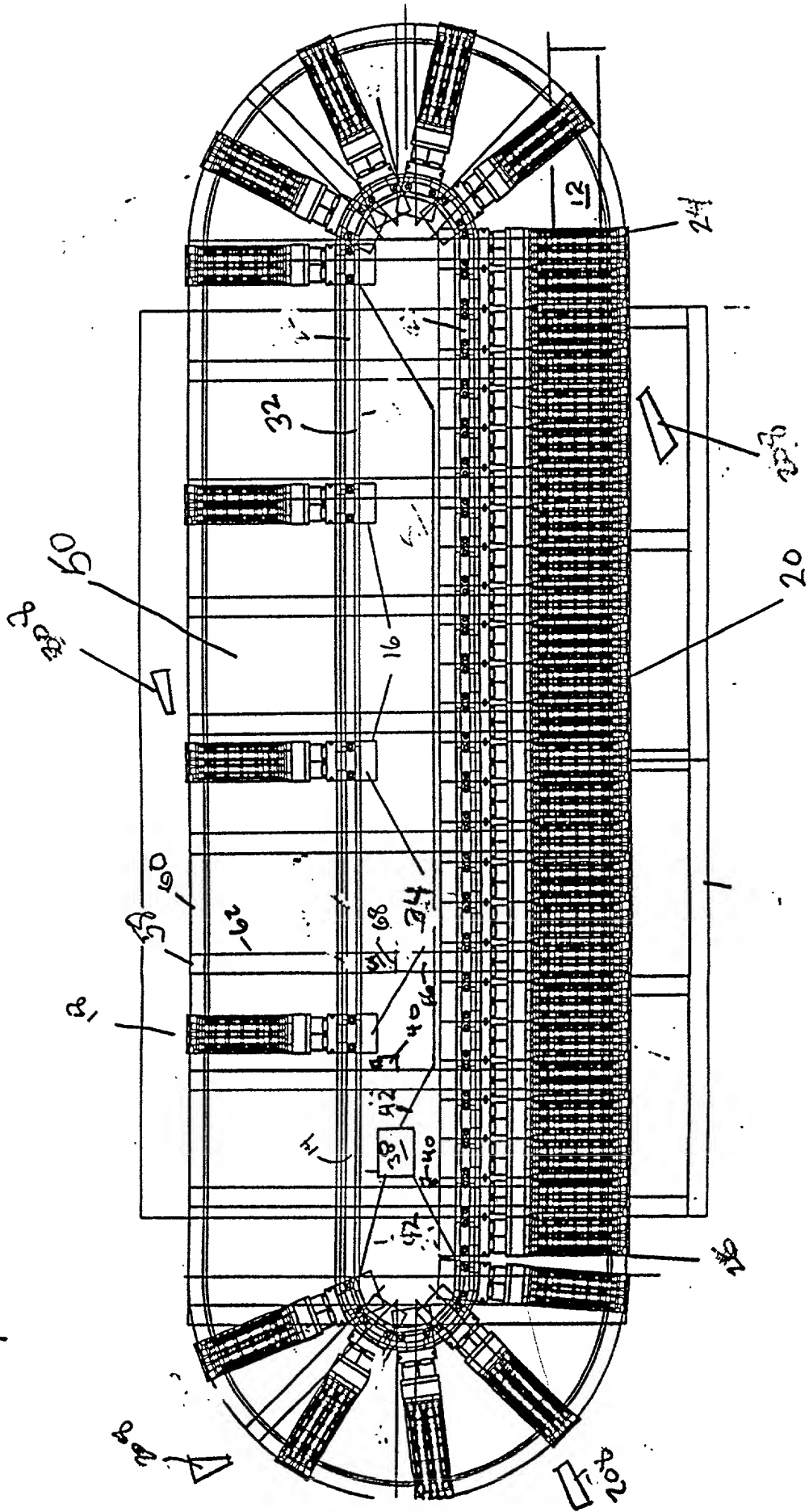
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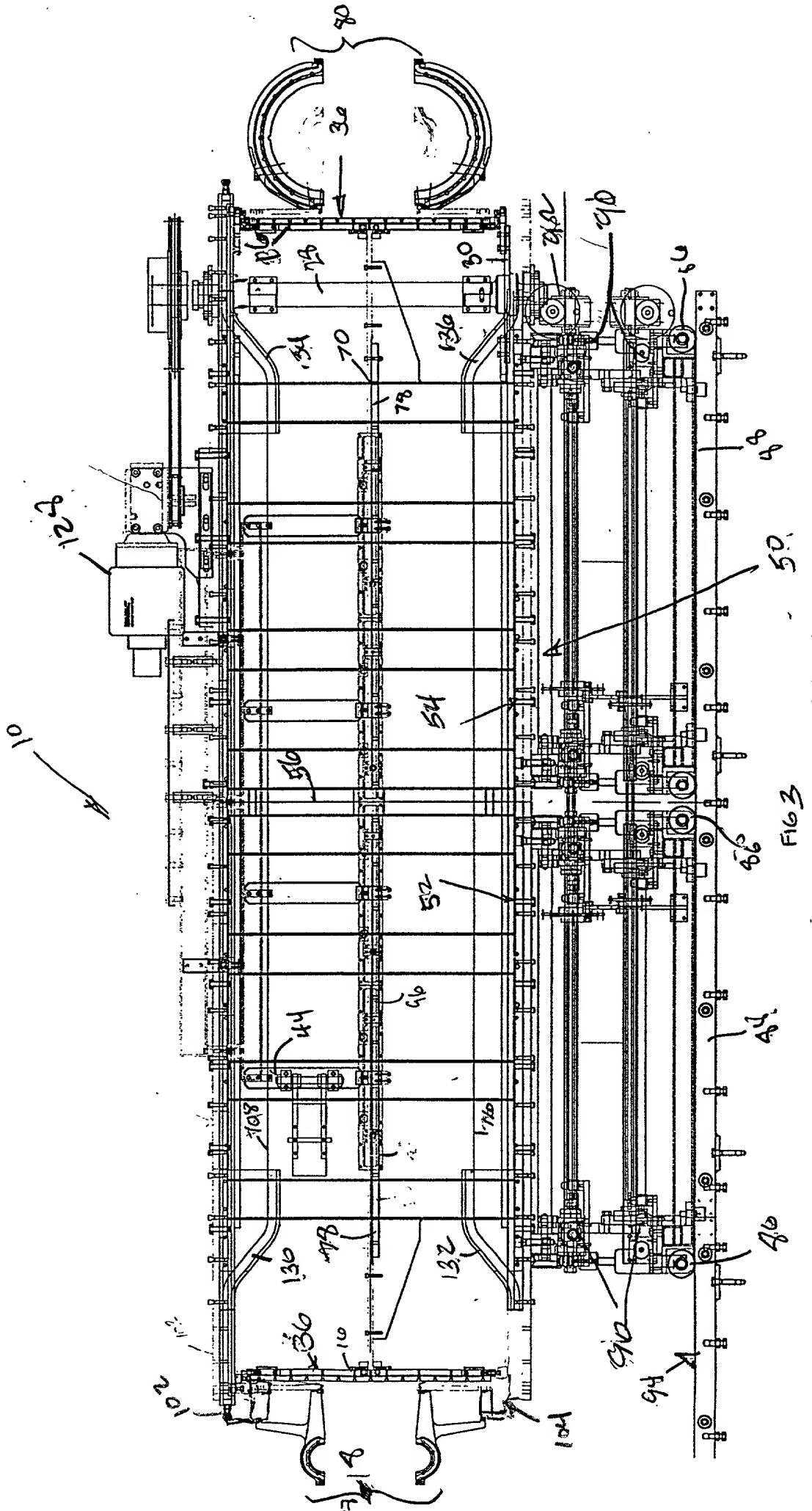


FIG 3



12



Figure 5

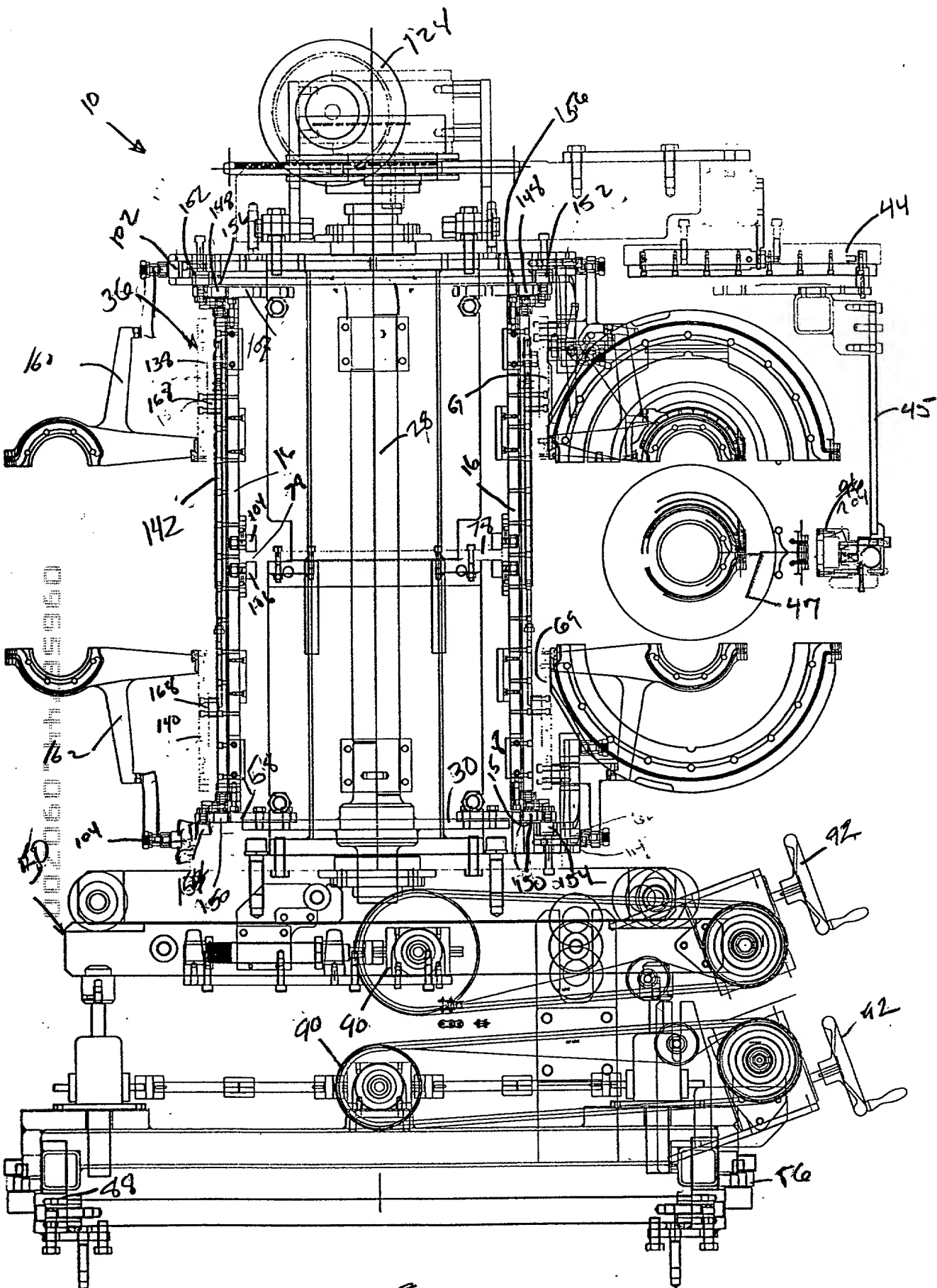


FIG 6

END VIEW

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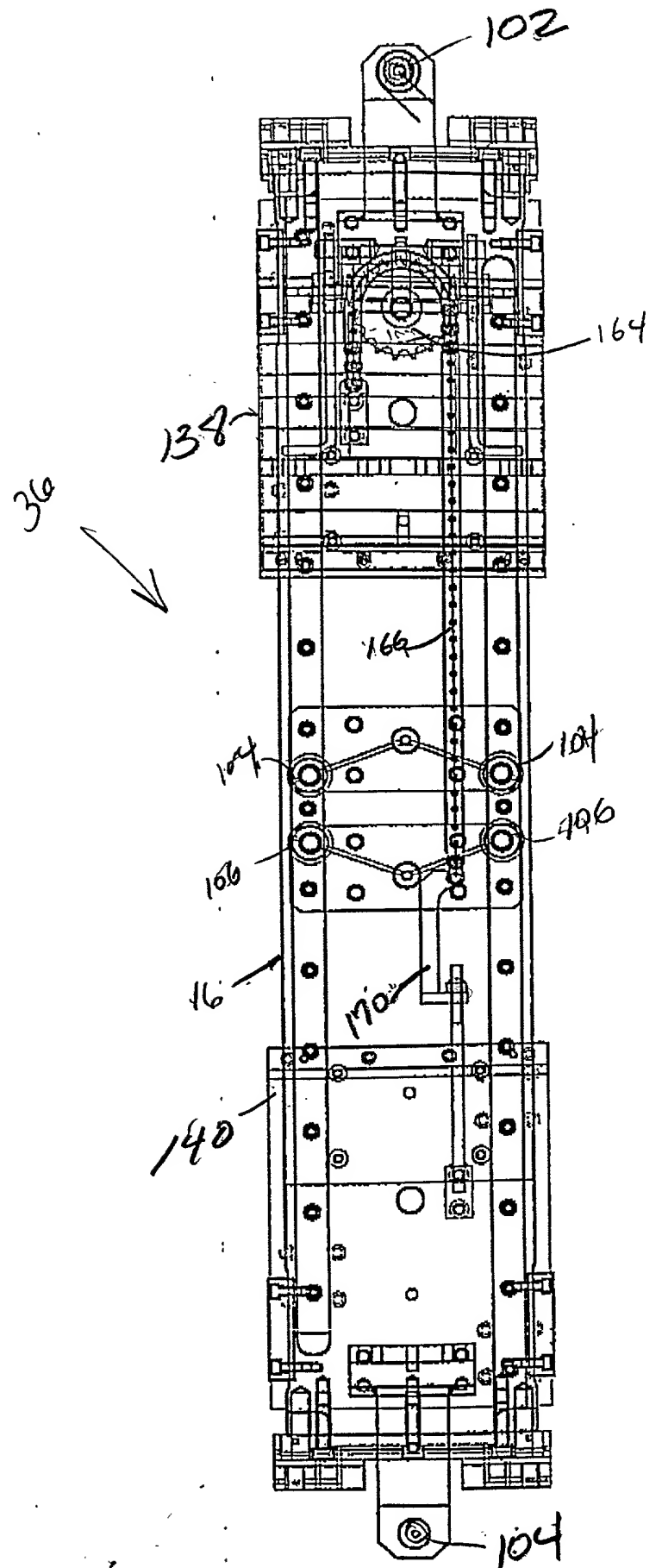


FIG 7

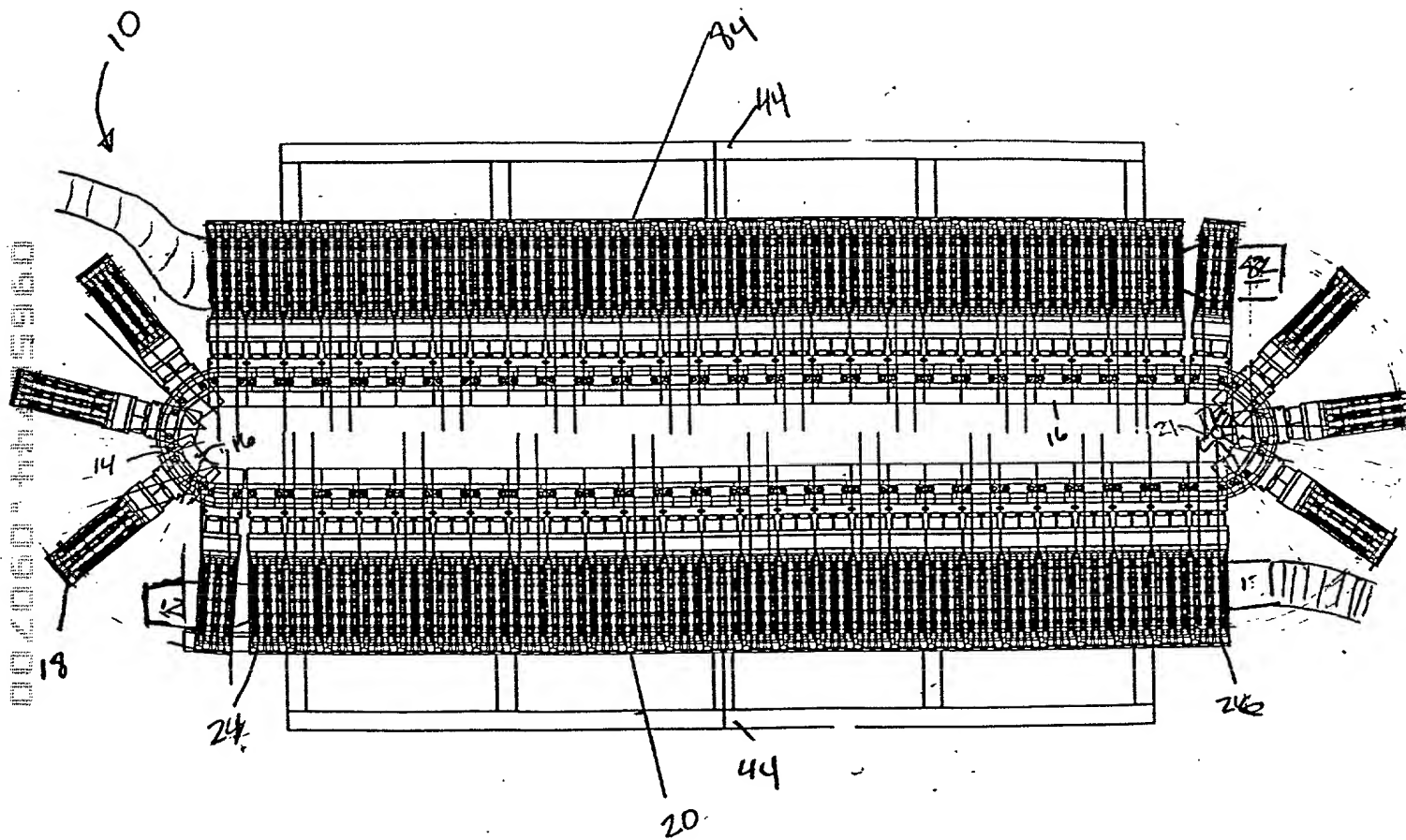


FIGURE 8

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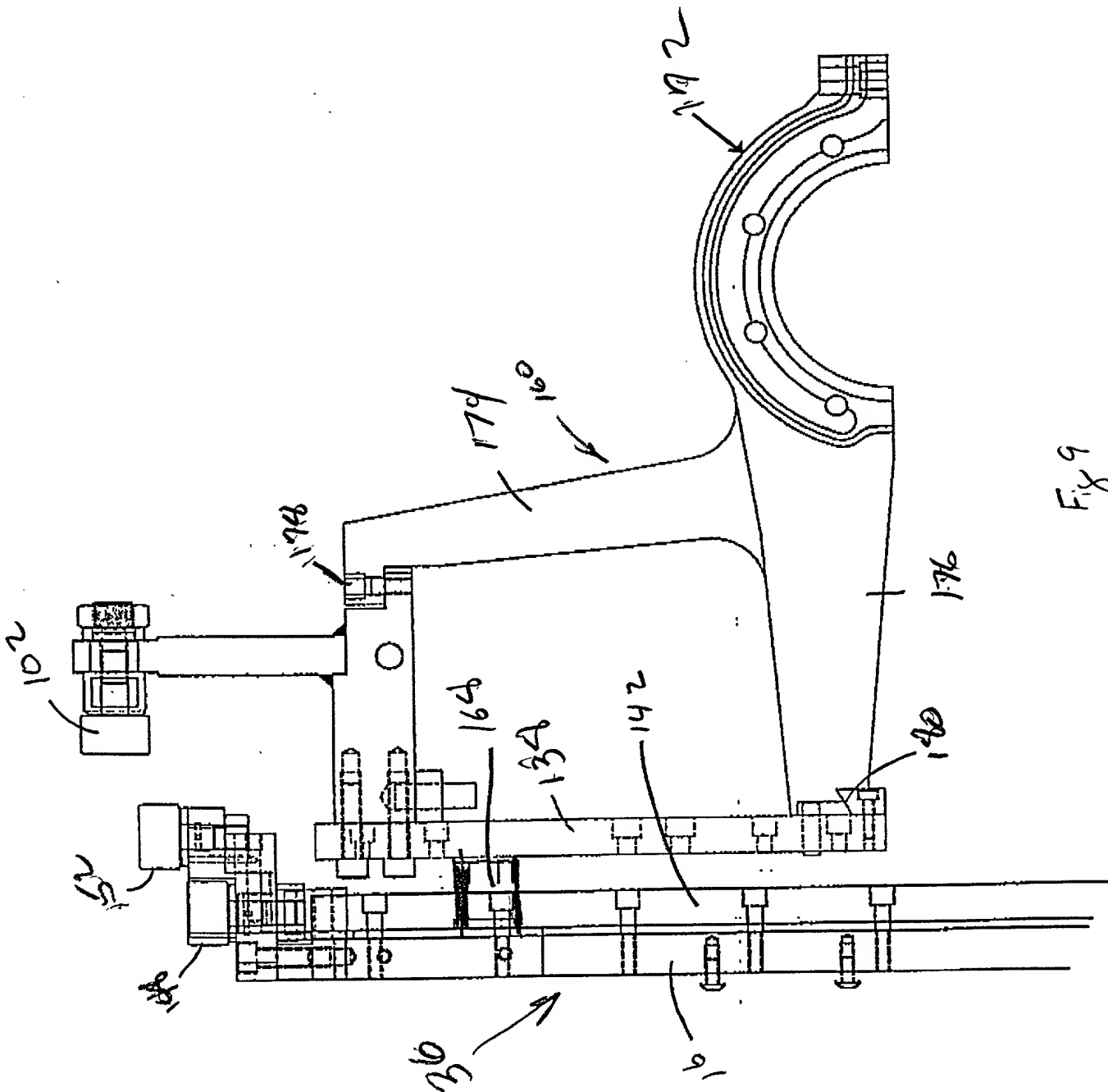


Fig 9

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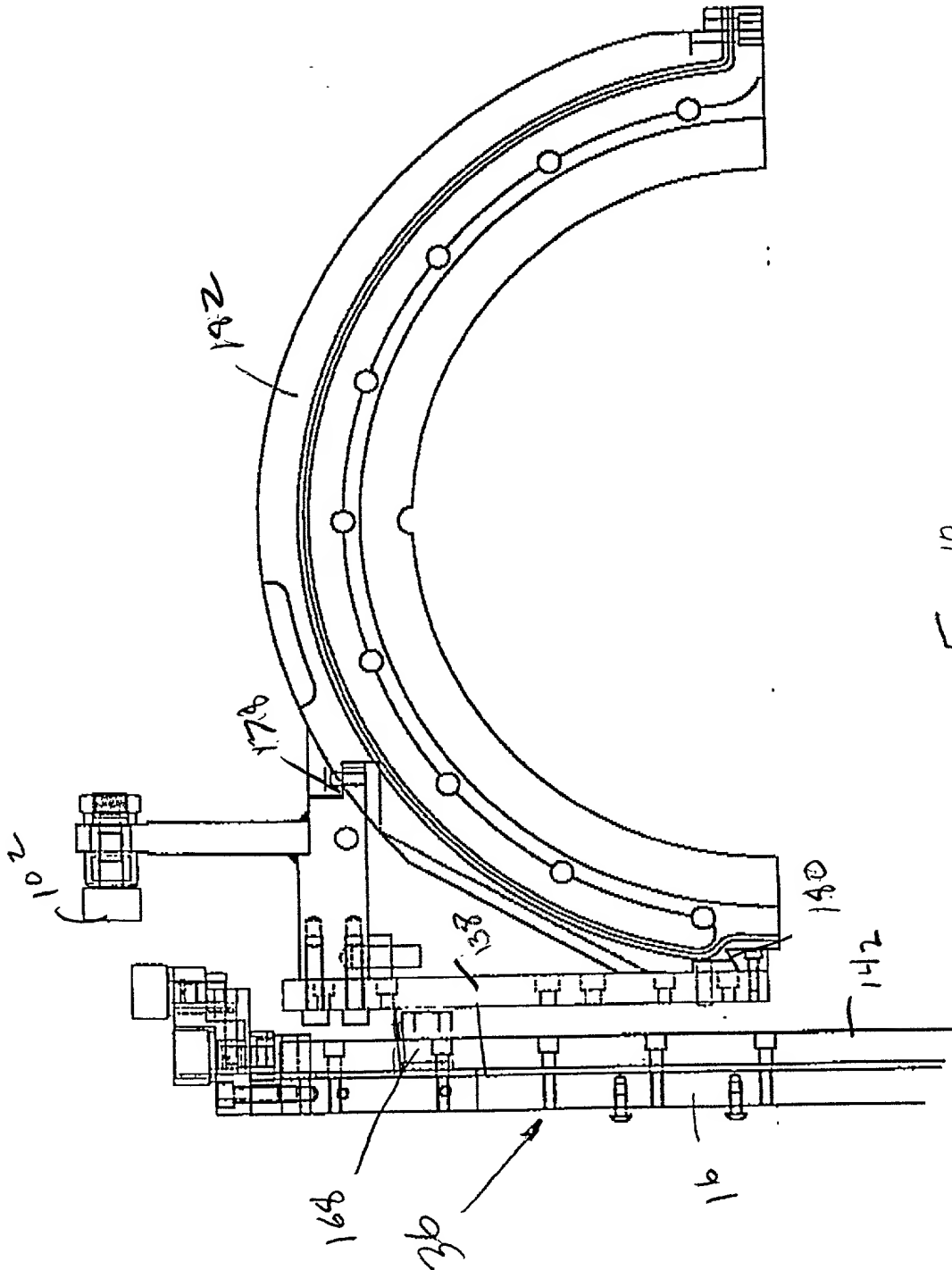


Fig 10



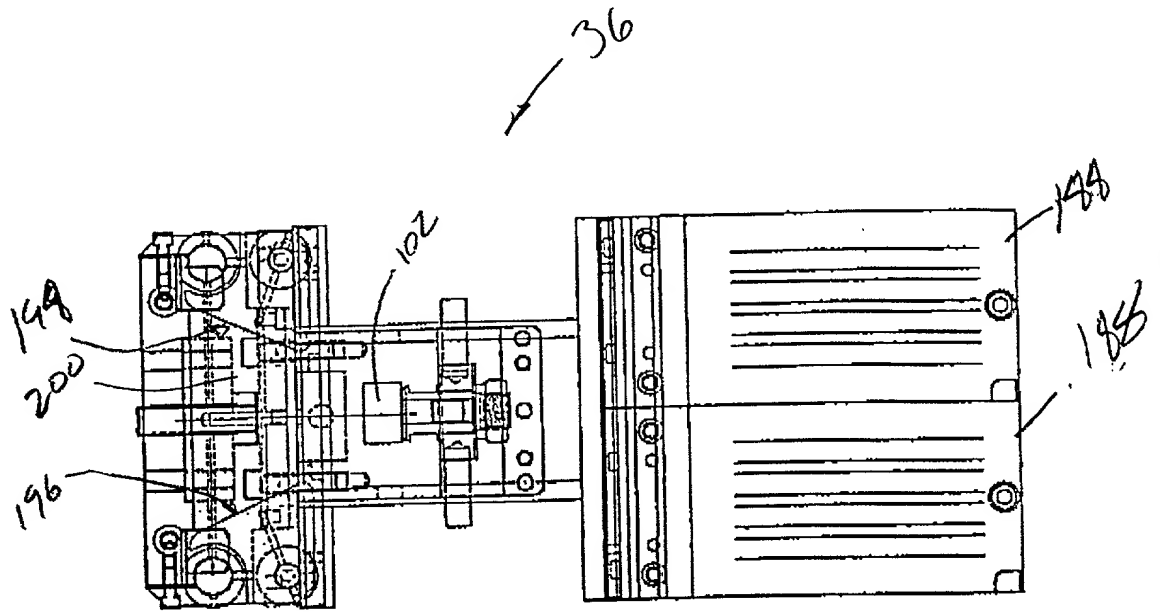


Fig 11

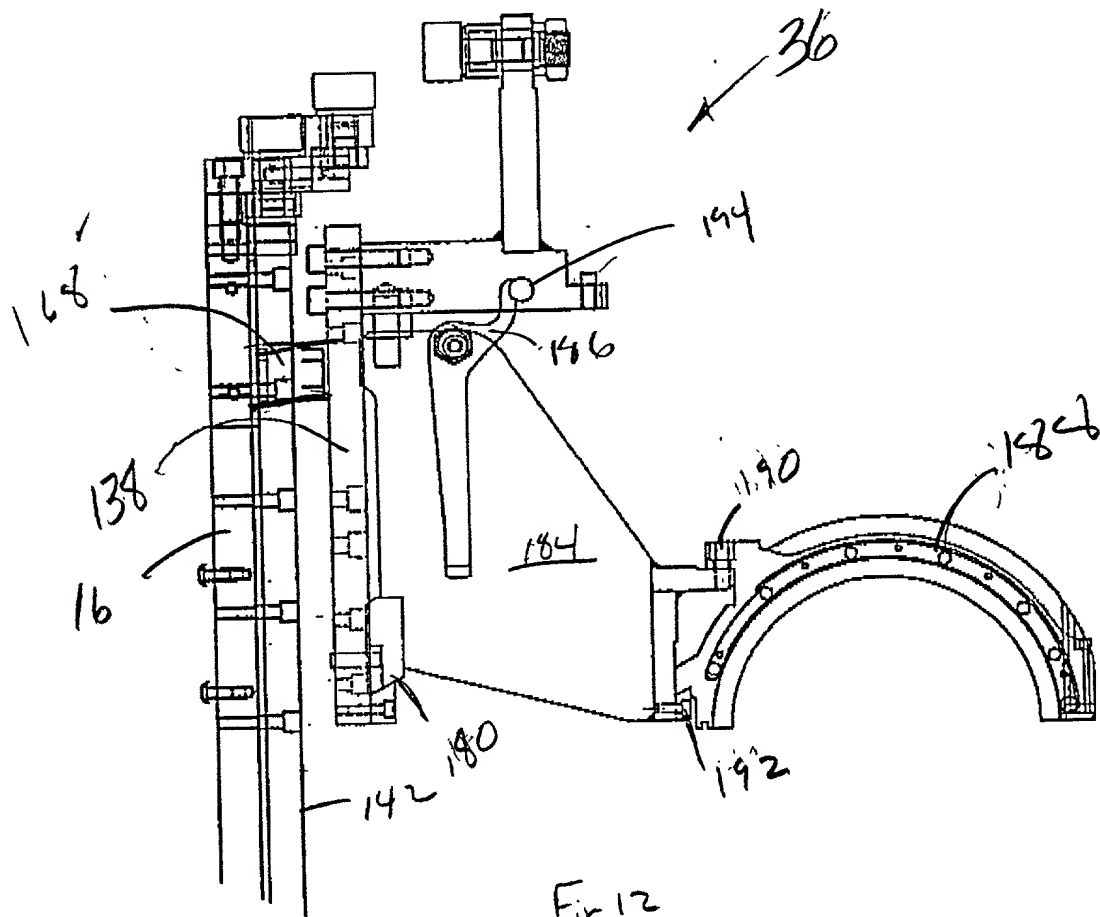


Fig 12

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P. 2

RULE 63 (37 C.F.R. 1.63)  
DECLARATION AND POWER OF ATTORNEY  
FOR PATENT APPLICATION  
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR PRODUCTION OF TUBING

the specification of which (check applicable box(s):

☒ is attached hereto.

☐ was filed on \_\_\_\_\_ as U.S. Application Serial No. \_\_\_\_\_

☐ was filed as PCT International application No. PCT// on \_\_\_\_\_  
and (if applicable to U.S. or PCT application) was amended on \_\_\_\_\_

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 C.F.R. 1.56(a). I hereby claim foreign priority benefits under 35 U.S.C. 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed or, if no priority is claimed, before the filing date of this application.

Prior Foreign Application(s):

Application Number	Country
Day/Month/Year Filed	

I hereby claim the benefit under 35 U.S.C. 120/365 of all prior United States and PCT international applications listed above or below and, insofar as the subject matter of each of the claims of this application is not disclosed in such prior applications in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose material information as defined in 37 C.F.R. 1.56(a) which occurred between the filing of the prior application and the national or PCT international filing date of this application:

Prior U.S./PCT Application(s):

Status: patented.

Application Serial No.	Day/Month/Year Filed	pending, abandoned
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U.S. Provisional App. No. 60/152,877	09/08/99	pending
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

And I hereby appoint Alan Ruderman, Reg. No. 25,369, Douglas T. Johnson, Reg. No. 31,841, Charles W. Forlidas, Reg. No. 41,758, Micra Vahdat, Reg. No. 43,965, and Stephen J. Stark, Reg. No. 43,152, with the law firm of Miller & Martin, 1000 Volunteer Building, 832 Georgia Avenue, Chattanooga, Tennessee 37402, telephone number (423) 756-6600, my attorney to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and with the resulting patent and to whom all communications are to be directed.

1) Inventor's Signature David A. Tripplett Date 9/6/00  
Inventor's Name (typed) David Tripplett USA  
First Middle Initial Family Name Citizenship

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Post Office Address 3601 Old Tazewell Road, Cleveland Tennessee Zip Code 37312

( X Additional Inventors on additional page)

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MILLER &amp; MARTIN

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P. 2

## RULE 63 (37 C.F.R. 1.63)

## DECLARATION AND POWER OF ATTORNEY

## FOR PATENT APPLICATION

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR PRODUCTION OF TUBING

the specification of which (check applicable box(es):

(X) is attached hereto.

( ) was filed on \_\_\_\_\_ as U.S. Application Serial No. \_\_\_\_\_

( ) was filed as PCT International application No. PCT// on \_\_\_\_\_  
and (if applicable to U.S. or PCT application) was amended on \_\_\_\_\_

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 C.F.R. 1.56(a). I hereby claim foreign priority benefits under 35 U.S.C. 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed or, if no priority is claimed, before the filing date of this application.

Prior Foreign Application(s):

Application Number \_\_\_\_\_ Country \_\_\_\_\_  
Day/Month/Year Filed \_\_\_\_\_

I hereby claim the benefit under 35 U.S.C. 120/365 of all prior United States and PCT International applications listed above or below and, insofar as the subject matter of each of the claims of this application is not disclosed in such prior applications in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose material information as defined in 37 C.F.R. 1.56(a) which occurred between the filing of the prior application and the national or PCT International filing date of this application.

Prior U.S./PCT Application(s):

Status: patented, \_\_\_\_\_ Day/Month/Year Filed \_\_\_\_\_ pending, abandoned \_\_\_\_\_  
Application Serial No. \_\_\_\_\_

U.S. Provisional App. No. 60/152,877 09/08/99 pending

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

And I hereby appoint Alan Rudezman, Reg. No. 25,369, Douglas T. Johnson, Reg. No. 31,841, Charles W. Foxlidas, Reg. No. 41,758, Mitra Vahdat, Reg. No. 43,965, and Stephen J. Stark, Reg. No. 43,152, with the law firm of Miller & Martin, 1000 Volunteer Building, 832 Georgia Avenue, Chattanooga, Tennessee 37402, telephone number (423) 756-6600, my attorney to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and with the resulting patent and to whom all communications are to be directed.

1) Inventor's Signature [Signature] Date 9/7/00  
Inventor's Name (typed) Garv Winner USA  
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SEP- 6-00 WED 1:08 PM MILLER & MARTIN

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P. 3

3) Inventor's Signature \_\_\_\_\_ Date \_\_\_\_\_  
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3) Inventor's Signature [Signature] Date 9-6-00  
Inventor's Name (typed) Tom McKeehan USA  
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4) Inventor's Signature [Signature] Date 9/6/2000  
Inventor's Name (typed) Clouds Ellie USA  
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